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W81XWH-11-2-0148 (NBTC2) Annual Report July 15, 2011 – July 14, 2012

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INTRODUCTION.

Scientific investigations, product development, and response to threats of endemic diseases and emerging pathogens are all undertaken in modern research biocontainment laboratories to reduce the risk of infection and lessen the impact of naturally occurring or man-made pathogens to humankind. There is, however, a risk that these activities could contribute to increase the potential exposure of individual scientists and technical staff, as well as surrounding communities, to dangerous infectious diseases if proper precautions are not taken and safe practices are not utilized in laboratories where this work is undertaken.

The threat is perhaps greatest within the international laboratory community where these dangerous pathogens may be routinely manipulated and investigated under less than ideal conditions by individuals who may lack adequate training or experience. Historically, this work was concentrated in a few research or governmental facilities where appropriate biocontainment existed and where a limited number of highly trained investigators conducted the research. Today, the investigation of emerging infectious diseases, the development of novel products to diagnose these infections, prevent infection and treat those who have become ill, has become a global enterprise. Unfortunately, some of the individuals and their parent organizations attempting to conduct this work do not have in place adequate facilities, training or administrative oversight to ensure that this important research and development is undertaken in the safest possible fashion, or that the products under development are evaluated safely.

Through the aims identified below, we are sharing the experiences gained as we operate the unique facilities of the Galveston National Laboratory (GNL) with others involved in laboratory research. Our experiences and lessons learned in the administration, investigation and effort to develop formal regulated studies were gained from years of biocontainment laboratory operations and from training the scientists who work within them. This unique and valuable experience is being shared with other biocontainment laboratory scientists and program directors around the world through the National Biocontainment Training Center's (NBTC) expanded scope of work.

The progress reported here complements activities summarized separately in a companion project (Award Number W81XWH-09-2-0053, also titled National Biocontainment Training Center). Together these awards support a coordinated effort to provide critical training and hands-on experience to U.S. national and international scientists working with especially dangerous pathogens that require special biocontainment facilities for their safe and secure handling.

BODY.

Research accomplishments associated with each specific aim are summarized below. This annual report covers July 15, 2011 – July 14, 2012.

Staffing Report.

James W. LeDuc serves as principal investigator for the training center and is responsible for oversight of program initiatives, fiscal management and progress reporting.

Christopher Gibbs assists in the training of building engineering fellows and provides hands-on guidance, especially in the care, maintenance and certification of the biological safety cabinets used in virtually every laboratory that handles pathogens.

Miguel Grimaldo directs the building engineering fellowship and provides lectures and hands-on guidance to fellows within the program. He also represents the program at meetings and events dedicated to biocontainment engineering.

Aaron Miller assists with the efforts to address Aim 4, to develop and implement training opportunities that focus on the safe and secure operations of novel laboratory instrumentation being introduced into the biocontainment laboratory environment.

John Morrill provides assistance in the training of students in the care, use and handling of laboratory animals within BSL-3 and BSL-4 biocontainment laboratories.

Alisha Prather assists in the preparation of reports, in the organization and implementation of guest lectures and with general communications of program activities. She also monitors relevant policy issues related to international biosafety and biosecurity.

Ronald Veselenak works with Aaron Miller to address Aim 4, to develop and implement training opportunities that focus on the safe and secure operations of novel laboratory instrumentation being introduced into the biocontainment laboratory environment.

Specific Aims

Aim 1. To provide standards-based biological containment laboratory safety knowledge to international partners.

Background: There is a massive unmet need for training in biosafety and biosecurity on an international level, which could ultimately stand to impact national security. To address this need we are expanding our efforts to engage international partners in an educational program that is structured around the same principles and practices as those currently in use within our existing funded NBTC, but focused on trainees from international centers possessing a biocontainment facility involved in the diagnosis, research and development, or the clinical care of patients suffering from especially dangerous infectious diseases. We strive to provide on-site training so that the instruction is tailored to meet the local facility and environmental needs and capacity of the end users. We focus on opportunities to “train the trainer” so that our efforts may be multiplied within that country. There is a fledgling network of national and regional organizations that are focused on biosafety, biosecurity and related fields of interest, and we are working with these organizations, and other professional groups to help build this network and further enhance this important aspect of research and development as it relates to infectious diseases.

Progress:

Progress during this past reporting year includes:

- We participated in the 3rd Biosafety and Biosecurity International Meeting (BBIC) held in Amman, Jordan in September 2011. The meeting was supported by HRH Prince El Hassan bin Talal and HRH Princess Sumayabint El Hassan. The focus of the conference was to continue with the development of biosafety and biosecurity awareness and implementation in the deferent countries on the Middle East and North Africa (MENA) regions. Representatives present from countries within the region included Jordan, Algeria, Yemen, Sudan, Morocco, Kuwait, Pakistan, and Oman. Dr. Brocard presented a talk (*pictured right above*) and 2 posters at the conference (*pictured right below: a photo of Dr. Brocard and HRH princess Sumaya bin El Hassan, she and her father HRH prince El Hassan bin Talal are strong supporters of the biosafety and biosecurity initiative in Jordan*). Immediately following the conference, interested countries could



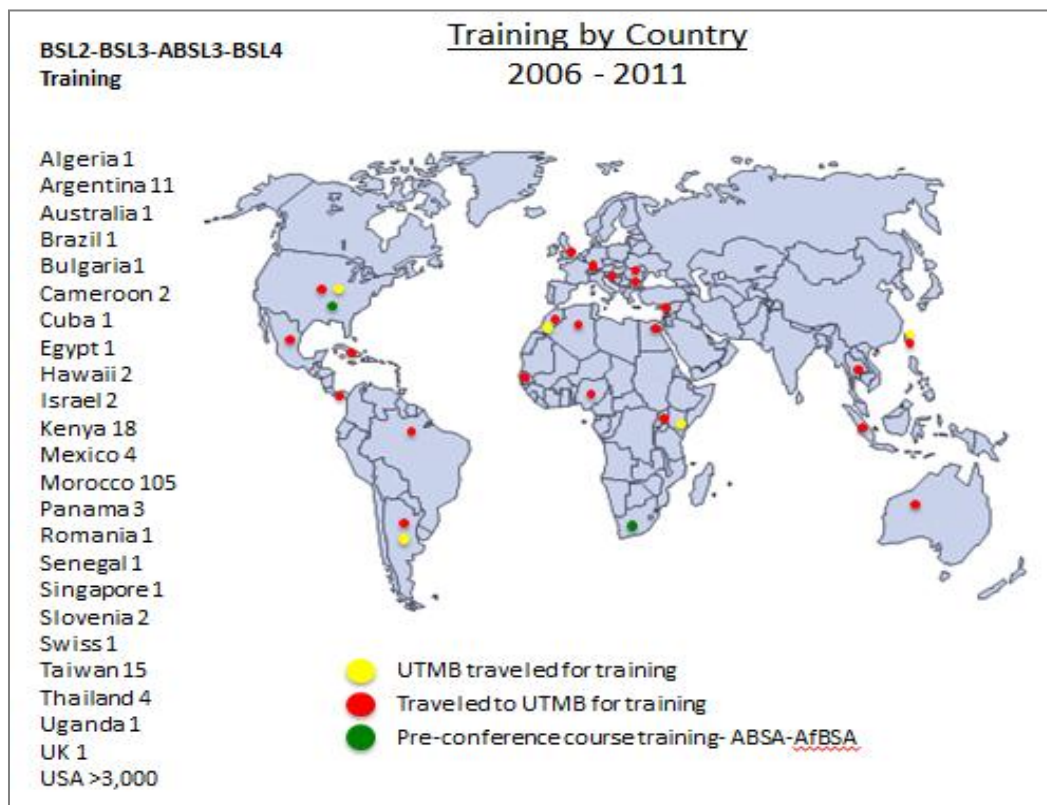
participate in a workshop to develop their respective national biosafety associations. Dr. Brocard gave a presentation to this group as well. A strong interest that emerged from both the 2nd and 3rd BBIC conferences is the development of national/regional or local training centers in biosafety and biosecurity. Dr. Brocard is a member of the working group dedicated to this effort, which will be further developed over the next year.

- Following the meeting in Jordan, Dr. Brocard was invited to teach a course on biosafety at the Pasteur Institute in Casablanca, Morocco. The training took place in December 2011 and was attended by 104 individuals representing the majority of the Pasteur Institute research and clinical laboratory staff. The emphasis of the instruction was on theoretical BSL2 practices. The initiative was promoted and supported by the Interim Director of the



institution and the departmental leadership. The trip and coursework were organized over a two-day onsite training session in Casablanca (*pictured above*). During day one Dr. Brocard toured the entire site which included a research component, clinical laboratories and laboratories for the public health department that oversees food, as well as a tour of water and food processing areas. Dr. Brocard fielded participant questions regarding biosafety as well as waste disposal processes that could be applied to their unique location. There was great awareness of possible health issues and exposure to the general population should biological and chemical waste be disposed of inappropriately. Day two consisted of a full day instructional presentation – in French – by Dr. Brocard that was extremely well attended. Roughly 50-60 people were expected to attend but 104 people ultimately attended, doubling participation and clearly demonstrating their interest in biosafety. Attendees posed thoughtful questions that confirmed the directors' intent to promote and implement good biosafety and waste disposal in the institution. Questions also focused on field work biosafety as many of the samples studied at the Institute are collected in the field. The NBTC will maintain contact with the Pasteur Institute to provide them with information and further training as needed to help them implement their biosafety goals.

- We provided BSL2 training to a research scientist from Monterrey, Mexico in September 2011. The researcher returned to our training center in January 2012 to complete BSL3 training. This researcher is now the manager of the BSL3 facility in Monterrey which was inaugurated in April 2012. Drs. Ann-Sophie Brocard, Janice Endsley and Alfredo Torres were invited by the University of Monterrey, Mexico to be present at their BSL3 grand opening in April 2012. The University invited their UTMB partners to join in the ribbon cutting ceremonies (pictured right). The specialty of the new university lab will be the molecular diagnosis of infectious diseases such as dengue, influenza and tuberculosis. The BSL3 lab was inaugurated by the NBTC's Dr. Anne-Sophie Brocard and Dr. Janice Endsley along with the CDC's Dr. Jeffrey Chang, directors of hospitals in the Mexican Institute of Social Security, and campus researchers and administration.
- We provided BSL3 training to three individuals from USAMRMC-AFRIMS stationed in Bangkok, Thailand. One individual from this laboratory stayed on and completed the ABSL3 training program as well. This person will be moving to a new duty station but indicated that they will strongly recommend that their replacement participate in our training program.
- Per the world map below, we continue to build ties with the Middle East and North Africa (MENA) regions to assist in their development of national and regional biosafety and biosecurity programs. Our training ties continue to expand as the demand for biosafety training grows.



- Also during this past reporting year, the training facility's engineering and maintenance team welcomed trainees from the Instituto Nacional de Enfermedades Virales Humanas "Dr. Julio Maiztegui" (INEVH) and the Universidad Tecnologica Nacional, both located in Argentina. Three trainees participated in the NBTC's Biocontainment Engineering Training Program in October 2011 held in the GNL. Course modules were tailored for the necessities of these particular institutions and included instruction in facility and primary containment requirements, ventilation mechanical systems and controls, facility adjustment and testing, decontamination and filtration systems, and documentation and record keeping among others. Advance paperwork was filed in compliance with 8 USC 1324b (a)(3) which regards training of non-US citizens on the UTMB campus. "It was more than just the training," visiting Engineer Ruben Fassio said about the NBTC coursework. "It was so much more than we expected or hoped for." The group spent 10 days touring the various laboratories, learning best practices and reviewing and solving problems they've encountered at home. They took a wealth of knowledge back to Argentina to improve their laboratories. "After my time here, I know what I'm doing right and where we need to make improvements," Fassio added. "Moving forward, I know the right way to do things and can train others the right way." That shared expertise represents one of UTMB's core values and encapsulates the goals of this unique biocontainment engineering training program. NBTC trainers continued the instruction by travelling to Pergamino, Argentina in May 2012 to provide hands-on instruction in the engineers' and researchers' own laboratory environment. As noted by the Institute's director Dr. Delia Enria, "The course was excellent, not only for the quality of the materials, organization, methodology, but also of the technical expertise of the people and the personal contacts that developed. I hope that the group continues with future projects, thus following the line of a friendship initiated more than 30 years ago in a new generation."



Pictured on previous page: Engineers from Argentina's Instituto Nacional de Enfermedades Virales Humanas "Dr. Julio Maiztegui" and the Universidad Tecnologica Nacional attended the NBTC's Biocontainment Engineering Training Program at UTMB in October 2011. They are pictured in the lab's mechanical spaces and with GNL Biocontainment Engineer Miguel Grimaldo and also receiving their certificates of completion from Grimaldo and GNL Director Dr. Jim LeDuc.

When NBTC trainers travelled to Pergamino in May 2012, they provided BSL3 training and facility/maintenance engineering training for their staff of 16 individuals. Each received BSL3 theoretical and practical training (one individual received theoretical training only) and 3 individuals received facility training. Each also participated in a BSL2 theoretical class; the course materials were printed in Spanish to facilitate understanding and comprehension.



Mr. Grimaldo, the NBTC's biocontainment engineer and his HEPA technician Mr. Christopher Gibbs provided training on *"Basic Concepts for the Design, Construction and Operation of BSL3 Laboratories and their necessary aspects for their certification,"* *"Biosafety Cabinet Certification Under the NSF 49 Standard,"* and also performed a site inspection of the INVEH's new BSL3 laboratory under construction.



Pictured on this page (top) are INEVH's team members who took part in the biosafety training provided onsite by the NBTC. Also pictured are Mr. Gibbs (bottom left) and Mr. Grimaldo (bottom right) during the maintenance and engineering instructional portions of the training program at the Pergamino laboratory.

- Mr. Grimaldo was invited to become a member of the **Biocontainment Engineering Working Group of the International Federation of Biosafety Associations (IFBA)**. One of the goals of the Working Group is to develop risk-management based biocontainment guidelines for biocontainment laboratories that will eventually be endorsed by international organizations such as WHO/OIE/FAO. During a June 2012 meeting of the IFBA held in Johannesburg, South Africa the NBTC was formally invited to become a member of the group which is committed to fostering collaborations with global organizations to promote and strengthen biosafety and biosecurity worldwide.
- In continuing work with our partners in Africa, Dr. Brocard taught a preconference course *“Building Your Biosafety Capacity – How to Get Started”* at the 3rd African Biological Safety Association (AfBSA) conference in Johannesburg, South Africa in June of 2012. Thirty conference attendees participated in Dr. Brocard’s course.
- The NBTC’s Belinda Rivera (pictured right) attended the 51st Annual Canadian Association for Laboratory Animal Science (CALAS) Symposium in Vancouver, British Columbia, June 2-5, 2012 and was sponsored by the Laboratory Animal Welfare and Training Exchange (LAWTE). Belinda provided a pre-conference workshop and co-presented with Bruce Kennedy, the current president of LAWTE. The workshop presentations included *“How to Train on Laboratory Animal Allergens”* and *“Training on Biocontainment”* and were attended by 30+ individuals. The 52nd Annual Symposium will be held in Winnipeg, MB, May 4-7, 2013 and will be a joint meeting with CALAS and LAWTE.



Aim 2. To provide the information and education necessary for a critical global discussion on the biosecurity, biosurety and related policy issues involved in the operation and maintenance of biocontainment facilities.

Background: A significant unmet need exists on the part of students, staff and faculty for greater knowledge regarding the origin, development, necessity and implementation of national policies on the vital topics of biosecurity, biosurety and related policy issues that form the foundation for the safe and secure operation and maintenance of biocontainment facilities. We continue to address this need through our ongoing lecture series led by distinguished guest speakers in our “Topics in Biosecurity Symposia Series.” It is clear, however, that much more could be done to meet this aim; consequently, we are working to engage a number of national and international partners to educate audiences, to stimulate discussion, and to consider and propose solutions to our biosecurity and biosurety concerns. This effort includes, for example, participation in the ongoing efforts of the U.S. National Academy of

Sciences and other organizations, and in other activities associated with the creation and operation of biocontainment facilities such as those in Central Asia, Asia, the Americas and in Africa. Our goal is to engage national and international leaders to develop and implement evidence-based policy discussions and eventual agreements that will enhance the security of biocontainment facilities around the world, including in those areas where little or no biosecurity infrastructure currently exists. This is being accomplished by participation in national, regional and international meetings and conferences and other outreach efforts, the facilitation of collaborative studies and investigations, the support of short- and long-term personnel exchanges to address specific goals in biosecurity, the development of programs suitable for a variety of educational methodologies, including ones that are web-based, and other timely opportunities designed to enhance global biosecurity.

Progress:

- Dr. Jim LeDuc of the NBTC participated in the 2011 Review Conference of the Biological and Toxin Weapons Convention in Geneva, Switzerland during which the U.S. National Academies of Science sponsored a side event to discuss the recently completed report, *“Anticipating Biosecurity Challenges of the Global Expansion of High Containment Biological Laboratories.”* Pre-publication copies of the report were provided to the approximately 50 delegates in attendance. Dr. LeDuc participated in the meeting held in Istanbul, Turkey last July that provided the foundation for this report, and he helped in the drafting of the final document (see below). The final report is now available online at the National Academy Press (www.NAP.edu), and a formal release and press conference was held at the National Academies of Sciences Keck Building in June 2012. Dr. LeDuc was one of the three panelists discussing the report.



Dr. James W. LeDuc is pictured at the 2011 Review Conference in Geneva, Switzerland alongside colleagues discussing the *“Anticipating Biosecurity Challenges of the Global Expansion of High Containment Biological Laboratories”* National Academies report.

- Based on the findings contained in this National Academy of Sciences report, a follow up meeting was held in Kiev, Ukraine in late April 2012. Dr. LeDuc participated in that meeting and contributed three presentations.

- During the reporting year, Dr. LeDuc also participated in a National Academy of Sciences workshop entitled “*Anticipating Biosecurity Challenges of the Global Expansion of High Containment Biological Laboratories*” held in Istanbul, Turkey with the involvement of 68 international experts representing 32 different countries. (Right: photo courtesy of Ben Rusek, CISAC.)



- Members of the NBTC participated as presenters at the American Association for Laboratory Animal Science (AALAS) 62nd National Meeting held October 2-6, 2011 in San Diego, California. The title of their presentation was “*Biocontainment Training and Access Process for Animal Care and Research Staff.*”
- A member of the NBTC participated in a meeting of the Global Virus Network, a fledgling group of leading experts in virology from around the world. This meeting was held on October 7-9, 2011 in Dublin, Ireland during which two formal presentations were made describing opportunities for training offered by the National Biocontainment Training Center and discussions of possible liaison actions with international organizations and other established networks that include biocontainment laboratories.
- A member of the NBTC was an invited expert guest for a meeting of the National Academy of Sciences’ Committee on Evaluation of the NBAF Site Specific Risk Assessment. This is a congressionally mandated effort by the NAS to evaluate a 2nd risk assessment on the proposed replacement laboratory for Plum Island Animal Center in Manhattan, Kansas. The evaluation includes the physical facility as well as operational and manpower issues (including training requirements for laboratory staff). The final report from this committee will be released on July 13, 2012.
- West Point cadets Nicholas Tubbs and Whitney Strong spent part of their summers as interns with the NBTC as a part of the Academy’s Academic Individual Advanced Development program. Cadet Tubbs, who is in his final year at West Point, did a biocontainment engineering internship with Miguel Grimaldo in the GNL. Cadet Strong, who is in her third year at the Academy, joined the lab of Dr. Alex Freiberg in Keiller for a research internship. Cadet Tubbs shadowed



Pictured (l to r): Miguel Grimaldo, Alex Freiberg, Cadet Strong, Cadet Tubbs and Jim LeDuc.

Miguel and Chris Gibbs during his stay, learning the basics of building engineering from air flow and filtration to electronic monitoring systems and routine maintenance. Cadet Tubbs commented, "I have learned a lot on the various biocontainment systems and the necessary workings behind a lab. I didn't really understand the complexities or redundancy of the systems before I came here, but now I am learning the various components to the lab." Cadet Strong was involved in two research projects to learn about different laboratory techniques. She worked on the characterizations of Rift Valley fever virus glycoprotein mutants and of recombinant expressed Nipah virus proteins.

- *Publications from the past reporting year include:*
 - Franz, David R. and LeDuc, James W, 2011. Balancing our approach to the insider threat. *Biosecurity Bioterrorism* 9 (3):1-2.
 - LeDuc, James W. and Franz, David R, 2012. Genetically engineered transmissible influenza A/H5N1: A call for laboratory safety and security. *Biosecurity Bioterrorism* 10 (3): 153-4.

Aim 3. To develop and implement a dedicated program to facilitate the establishment, maintenance and administrative oversight of operations of biocontainment facilities.

Background: There are unique requirements for the operations of a biocontainment facility that extend beyond the scientific investigations and the safety and security infrastructure. For facilities such as the regional and national biocontainment laboratories constructed with support from NIH, as well as the independent commercial and not-for-profit institutions and foundations that manage biocontainment facilities and the international containment laboratories such as those now under construction in Central Asia under U.S. Department of Defense support, there is a need for a specialized administrative structure and culture. This culture must be sensitive and responsive to local needs and also address the unique operational challenges associated with the conduct of research and development involving highly dangerous infectious pathogens and the specialized business practices that are critical to sustaining the enterprise. These challenges are especially difficult ones that vary by organization with no standard model fully appropriate for all facilities.

There are some general principles that must be followed; however, in many instances the operational environment at each facility is unique and demands specialized attention. We captured these lessons learned as we brought the GNL online and embarked on the full operation of this national resource. We are developing plans to offer short and longer term training opportunities to administrative staff and institutional leadership of containment laboratories, as well as to students interested in careers in this field. Longer term fellowships are being established to provide relevant hands-on experience to the next generation of the biocontainment industry leaders. We are also creating a standardized checklist of essential tools, skills and procedures that are critical to the safe and secure operations of a biocontainment laboratory. This will include best business practices to ensure fiscal stability in

the face of the high costs of security, utilities and specialized equipment required for successful operations.

Progress: A researcher from Turkey who is directly involved in both the scientific investigations and oversight of a newly constructed BSL3 laboratory in Istanbul that will focus primarily on pathogens of agricultural and human health importance began this long-term training program in January 2012. The individual is a DVM, PhD with extensive experience in vector-borne diseases and virology. In addition to her training on containment laboratory operations and management, the scientific focus of her work while at UTMB involves investigations of Crimean-Congo hemorrhagic fever, an important endemic virus disease of growing significance in Turkey and Central Asia. Her work involves virus transmission studies using vector tick colonies that she has helped to establish here at UTMB from material originally collected in Turkey.

Aim 4. To develop and implement training opportunities that focus on the safe and secure operations of novel laboratory instrumentation being introduced into the biocontainment laboratory environment.

Background: The rate of change in laboratory instrumentation and adaptation of novel technologies to the laboratory setting is progressing rapidly. Routine laboratory procedures are becoming more and more automated, saving technicians and investigators time and effort. Technologies that once were so costly as to limit their use to only a few facilities are now affordable for many laboratories. For example, the sequencing of a pathogen or host that once required months or even years of specialized investigation and costly outsourcing, now can be provided in a matter of hours through the use of automated, high throughput instruments never before available to the research community.

As these modern advances make their way into biocontainment laboratories where highly dangerous pathogens are studied, it is not always clear what safety concerns might exist. For instance, many automated pieces of equipment such as flow cytometry include procedures that could generate an infectious aerosol during wash steps or other routine operations, which might place laboratory workers at risk of accidental infection if appropriate precautions are not utilized. Decontamination of such instrumentation for service and maintenance is another major challenge. In addition, modern imaging equipment is now finding greater application within the research community. Both *in vivo* and *in vitro* imaging techniques and equipment are becoming available for use within the biocontainment laboratory environment for use in pathogenesis studies involving live animals or cell cultures infected with especially dangerous agents. Further, it is now possible to grow relatively large volumes of pathogens using modern bioreactor technology. The development of safe operating procedures, guidelines for product processing, and training on the safe use of each piece of equipment necessary for the production, processing and storage of the resultant product is required. There is an urgent need to develop well-validated procedures to safely and securely conduct these important studies while ensuring the safety of investigators and the surrounding environment.

Under this aim, we are focusing specifically on those processes that might generate infectious aerosols when live pathogens are investigated and on those instruments that will require decontamination prior to service by external personnel who may not be equipped to work in a biocontainment setting. A product of this effort will be the creation of detailed standard operating procedures to ensure the safe analysis of material originating from potentially infectious substances and the development of specialized safety interventions to be used to protect workers at all levels of biocontainment. Our efforts are focused on the BSL2 laboratories where the majority of this equipment is located and where the greatest number of users exists; however, we are also examining these resources when they are in use within BSL3 and BSL4 laboratories.

Progress: Administrative procedures are in progress to establish support for personnel under this aim. The funds have not yet been expended. An update will be provided in future reports.

Aim 5. To develop and implement policies, procedures and training programs for the safe and secure conduct of preclinical studies to be undertaken within biocontainment at biosafety laboratory levels 2, 3 and 4 (BSL2, 3, 4) in compliance with the U.S. Food and Drug Administration(FDA) Good Laboratory Practice (GLP) regulations (21 CFR Part 58).

Background: There is a growing requirement for the development of diagnostic tests, drugs and vaccines for use in the recognition, treatment and prevention of biological terrorism threats and emerging infectious disease agents. Bioterrorism threats are among the most dangerous infectious pathogens known to humankind, and their safe and secure handling must be done within the confines of specially constructed biocontainment laboratories. The level of biocontainment needed is specific to each particular pathogen and is layered from the lowest level, BSL2, to “high containment” found in BSL3 facilities, to “maximum containment” found only in BSL4 laboratories (highly complex facilities built with special air handling, waste sterilization and other safety and security protections incorporated into the physical plant and routine operations).

In order to be formally approved for use in humans, products developed for potential application in humans must be evaluated for safety and efficacy during preclinical studies using laboratory animals under safe conditions of biocontainment prior to undergoing clinical safety and efficacy testing in human clinical trials. In addition, in certain cases where efficacy testing in humans is logistically or ethically impractical, products may be approved under the FDA’s “Animal Rule” which allows for efficacy to be demonstrated in appropriate animal models. Preclinical safety and animal rule efficacy studies must be conducted by appropriately trained personnel under standardized conditions using well defined procedures and validated equipment as described in 21 CFR Part 58, commonly referred to as Good Laboratory Practices.

Each of these studies is likely to encompass activities across multiple levels of *in vitro* and animal biocontainment and, to date; few organizations have undertaken carefully regulated studies on these highest threat pathogens. Processes and procedures needed for formal GLP

studies in biocontainment have generally not been created or have not been tested in actual working biocontainment facilities.

Progress: We are currently preparing for support of GLP-compliant studies to be performed at BSL3 or BSL4 using laboratories in the GNL and elsewhere on the UTMB campus. The FDA requires that critical drugs and reagents are protected from potential mix-ups or contamination. We are preparing standard operating procedures and associated equipment files for a dedicated regulatory studies support laboratory and general BSL2 laboratory, located on the 6th floor of the GNL.

The dispensary laboratory is intended to provide a dedicated space for critical reagent (e.g. test and control articles) receipt, storage and handling and is equipped with a suite of basic laboratory equipment that has been validated according to a set of general operating parameters for storage and measurement of reagents. Likewise, a general BSL2 laboratory is being established for use on regulated (GLP) and other sponsored studies that require restricted access and/or segregation of laboratory work to meet compliance or contractual requirements. In addition to standard equipment consistent with other GNL BSL2 laboratories, this laboratory will house blood and clinical chemistry analyzers and a Tecan automated plate handling system. These lab spaces can be used to support studies in a GLP compliant manner and, when not in use for a compliant study, will be used to train facility personnel and validate potential test models and supporting procedures.

GNL and UTMB personnel are continuing to develop standard operating procedures and associated documentation to support safe and secure future operations of those laboratories and to facilitate training of study personnel in appropriate performance and documentation of activities that would be performed in those dedicated laboratories. In addition, personnel are working with other GNL cores/divisions, UTMB Environmental Health and Safety, and individual investigators to develop specific procedures for quality assurance unit (QAU) oversight of studies performed in high biocontainment laboratories at UTMB and for validation of significant laboratory equipment, methodologies and information systems infrastructure that may be used in support of future product development-related studies in compliance with FDA regulations for product licensure. This is a long process that will require significant investments of time and effort to develop the robust program needed to ensure successful regulated studies conducted under biocontainment conditions.

Key Research Accomplishments. Significant progress has been made in addressing each of the Aims identified for study, with the exception of Aim 4, that deals with safety precautions of modern laboratory equipment. The level of international engagement with laboratory scientists and biosafety officers around the world has been exceptional and clearly demonstrates a substantial demand for the training we are offering. We have been especially gratified by the warm reception and very positive comments that we have received from our colleagues dealing with biocontainment building maintenance and operations. This is a critically important link in the continued safe and secure operations of biocontainment laboratories, yet there is virtually no international source of guidance or established best practices. We are proud to be at the forefront of addressing this need.

Reportable Outcomes. Important partnerships and exchanges have been established both with international biosafety associations and with the individual leadership of international biocontainment laboratories. Further, several individuals have benefited from extensive training on site at UTMB or at their home facility. These are significant steps towards developing leaders around the world and will serve as a foundation for future growth and dissemination of best practices to a much wider international audience.

Conclusions. The value of international engagement on a personal level cannot be overstated. The friendships and mutual respect that develops through our training efforts not only enhances the safe and secure operations of containment laboratories around the world, but it also fosters a culture of trust and transparency that directly enhances global security.